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ADDRESSING METHOD FOR PLASMA DISPLAY PANEL BASED ON SEPARATE EVEN-NUMBERED AND ODD-NUMBERED LINE ADDRESSING

This application claims the benefit under 35 U.S.C. § 365 of International Application PCT/FR99/02474, filed October 13, 1999, which was published in accordance with PCT Article 21(2) on May 5, 2000 in French, and which claims the benefit of French Application 9813314, filed October 23, 1998.

BACKGOUND OF THE INVENTION

1. Field of the Invention

The invention relates to an addressing process and device for plasma panel based on a separate addressing of the even lines and of the odd lines.

2. Description of the Prior Art

On plasma screens, the grey level is not produced in a conventional manner using amplitude modulation of the signal but rather using temporal modulation of this signal, by exciting the corresponding pixel for a greater or lesser time depending on the level desired. It is the phenomenon of integration by the eye which makes it possible to render this grey level. This integration is performed during the frame scan time.

The eye actually integrates much faster than the frame duration and is therefore liable to perceive, in cases of particular transition of the addressing bits, variations in level which do not reflect reality. Contour defects or "contouring" as it is known, may thus appear in the moving images. These defects may be compared to poor temporal restitution of the grey level. More generally, false colours appear on the contours of objects, each of the cells of a colour component possibly being subject to this phenomenon. This phenomenon is even more harmful when it occurs in relatively homogeneous zones.

A simple theoretical solution for limiting the appearance of false contours is known from the prior art to be described for example in EP-A-0 874 349 or FR-A-2 762 704 corresponding to US patent application no. 09/061,419 and which consists in multiplying the number of sub-scans so that the disturbances related to the modifications of the video level from one frame to the other are made minimal. The necessary additional sub-scans originate from the scans saved by the simultaneous addressing of

two adjacent lines. However, this simultaneous addressing causes losses of resolution, the information copied over from one line to the other being obtained by recoding the grey level, using the possibilities of redundancy of codes. However, it is not possible to curb the magnitude of these losses of resolution.

Another problem of the prior art relates to the priming conditions.

One of the features of the plasma cell is that it has a triggering threshold which is not independent of the state of its immediate neighbors. A cell will be all the more easily excitable if its neighbors are excited, and one in fact speaks of a priming phenomenon. Since the barriers separating the various cells are not completely hermetic, a certain number of free electrons originating from the excited neighboring cells will promote the excitation of the addressed cell.

This priming problem is in fact magnified by the nonuniformity of the panel. In order to promote the excitation of the cells, it is always possible to vary the control voltages, but this becomes impossible when the glass panes do not have for example the same spacing over the entire panel. In this case, the compromise found at the level of the control voltages does not make it possible to optimize the illuminating of all the cells.

Another problem of the prior art relates to the quantizing of the low levels.

The plasma panel, unlike the cathode-ray tube, possesses a linear response, that is to say the luminance level emitted is strictly proportional to the video level. The present-day display systems are based, to a large extent, on the use of cathode-ray tubes. An operation of a priori compensation of the response of the cathode-ray tube is then carried out at the picture-taking level. To be able to correctly display such a signal on a plasma panel, it is therefore necessary to perform the inverse correction (gamma correction) to ultimately obtain the actual information.

Figure 1 shows the profile of the compensation curve 1 for the response of a tube on emission, the abscissa axis representing the input video level and the ordinate axis representing the output video level after correction. Curve 2 corresponds to a linear response obtained after applying the correction as represented at 3.

The consequence of this correction is to very greatly limit the quantization of the low levels in so far as several levels of the input signal may correspond to a level of the output signal. This is especially true for the low levels, for example in the zone demarcated at 4 where the input levels lying between 0 and 15 correspond to a single output level equal to zero.

For perfect rendering of these low levels, it would be necessary to employ more than 8 quantization bits (10 or 12 for example).

SUMMARY OF THE INVENTION

The aim of the invention is to solve the drawbacks cited. Accordingly, [the subject of] the invention is a method for addressing cells arranged as a matrix array, each cell being situated at the intersection of a line and a column. The array has line inputs and column inputs for displaying grey levels defined by video words making up a digital video signal and defining an image. The column inputs each receives a control word for this column corresponding to the video word relating, for this column, to an addressed line, this word being composed of n bits transmitted sequentially, each sequence corresponding to a sub-scan, each bit triggering or not, according to its state, the illumination of the cell of the addressed line and of the column receiving the control word, for a time proportional to the weight of this bit in the word. A different coding of the column control words is performed depending on whether the word relates to an even or odd line, this difference consisting in the fact that at least m successive bits of specified ranks have different weights from one control word to the other, the sum of the weights of these bits remaining identical from one control word to the other, so as to obtain writing instants which are substantially different from one line to the next.

According to a variant of the method, writing is simultaneous on two successive lines for at least the first bit of the m successive bits of a control word relating to one of the two lines.

According to another variant, at least two successive lines are selected simultaneously for at least one of the bits of the column control words, the weight of which is the same from one control word to the other.

According to another variant, at least one of the bits, which has an identical weight from one control word to the other, is used to code a partial value of luminance common to two successive lines and writing is simultaneous on these lines for this bit of the control word relating to one of the two lines.

According to another variant, the method is implemented for a limited number of lines of the matrix array, these lines corresponding to the zones of the image defined by the video signal having strong vertical transitions, the other zones utilizing sub-scans corresponding to an addressing process for which the column control words all have the identical weights from one line to the other.

According to another variant, the process is implemented for images having strong vertical transitions, the other images utilizing an addressing process for which the column control words all have the identical weights from one line to the other.

According to another variant, the switchover from the first addressing method comprising n sub-scans to a second addressing method comprising a larger number of sub-scans and for which the column control words have a larger number of bits having identical weights from one line to the other is performed by replacing the selection of a line l while writing a bit of different weight on the line l, in the first method, by the selection of the line l and of the immediately preceding or immediately following line for a simultaneous writing on these two lines, in the second method.

The invention also relates to a device for implementing the above method comprising a video processing circuit for processing the video data received, a correspondence memory for transcoding this data, a video memory for storing the transcoded data, the video memory being linked to column supply circuits for controlling the column addressing of the plasma panel on the basis of column control words, a control circuit for line supply circuits linked to the video processing circuit so as to select the lines. The video processing circuit and the transcoding circuit perform a different coding of the column control words depending on whether the word relates to an even or odd line, this difference consisting in the fact that at least m successive bits of specified ranks, from among the bits to be transmitted have different weights from one control word to the other, the sum of the weights of these bits remaining identical from one control word to the other, so as to obtain writing instants which are substantially different from one line to the next.

According to a variant embodiment of the device, the circuit for controlling the line supply circuits simultaneously selects two consecutive lines during the transmission by the column supply circuits of the first bit of the successive bits of a control word relating to one of the two lines.

According to another variant, the device also comprises a selection circuit receiving the video data so as to select a coding of the column control words corresponding to an addressing according to n sub-scans or to an addressing corresponding to a larger number of sub-scans, as a function of the variations in luminance from one line to the other of an image.

The addressing method according to the invention consists in separating the addressing of the even lines from that of the odd lines by using a different coding of the column control words. The instants of writing from one line to the other, for certain bits of the control words, are substantially different. The priming of the excitations of the cells is thus promoted.

This method makes it possible to perform a partial and variable copyover of the video information from one line onto the other. It is thus possible to play around with the number of sub-scans/loss of vertical resolution compromise. It is then possible, as a function of the content of the video, to modify, for each of the pairs of lines, the number of sub-scans and hence consequently the maximum difference permitted between two luminance values allowing an error of less than the LSB.

By virtue of the invention, the contouring effects are eliminated or at least greatly reduced, the quantizing of the low levels is improved.

BRIEF DESCRIPTION OF THE DRAWINGS

Other features and advantages of the invention will become clearly apparent in the following description given by way of nonlimiting example and with regard to the appended figures which represent:

- Figure 1, a compensation curve for the response curve of a cathode-ray tube,
- Figure 2, a timing chart showing coding levels as a function of time,
- Figure 3, a scanning scheme for a plasma panel according to the prior art,
- Figure 4, a scanning scheme for a plasma panel according to the invention,
- Figure 5, a timing chart for the writing of two consecutive lines according to the invention for bits of column control words having different weights,

- Figure 6, a timing chart for the writing of two consecutive lines according to the invention for bits of column control words having identical weights,

- Figure 7, an example of writing on two consecutive lines for bits of column control words having identical weights,

- Figure 8, an example of writing on two consecutive lines for bits of column control words having different weights,

- Figure 9, a device according to the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

A plasma panel consists of two glass panes separated by about a hundred microns. This space is filled with a gaseous mixture containing neon and xenon. When this gas is excited electrically, the electrons orbiting the nuclei are extracted and become free. The term "plasma" denotes this gas in the excited state. Electrodes are silk-screen printed on each of the two panes of the panel, line electrodes for one pane and column electrodes for the other pane. The number of line and column electrodes corresponds to the definition of the panel. During manufacture, a barrier system is set in place which makes it possible physically to delimit the cells of the panel and to limit the phenomena of the diffusing of one colour into another. Each crossover of a column electrode and a line electrode will correspond to a video cell containing a volume of gas. A cell will be referred to as red, green or blue depending on the luminophore deposit with which it will be covered. Since a video pixel is made up of a triplet of cells (one red, one green and one blue), there are therefore three times as many column electrodes as pixels in a line. On the other hand, the number of line electrodes is equal to the number of lines in the panel. Given this matrix architecture, a potential difference merely needs to be applied to the crossover of a line electrode and a column electrode in order to excite a specific cell and thus obtain, point-wise, a gas in the plasma state. The UV generated when exciting the gas will bombard the red, green or blue luminophores and thus give a red, green or blue illuminated cell.

A line of the plasma panel is addressed as many times as are defined therein sub-scans in the grey level information to be transmitted to the pixel, as explained later. The pixel is selected by transmitting a voltage termed a write pulse, by way of a supply circuit, to the whole of the line corresponding to the selected pixel while the information corresponding to the grey level value of the selected pixel is transmitted in parallel to all the electrodes of the column in which the pixel lies. All the columns are

supplied simultaneously, each of them with a value corresponding to the selected pixel of this column.

With each bit of the grey level information there is associated a time information item which therefore corresponds to the bit illumination time or more globally to the time between two writings: a bit of weight 4 having the value 1 will thus correspond to the pixel being illuminated for a duration 4 times greater than an illumination corresponding to the bit of weight 1. This hold time is defined by the time separating the write cue from an erase cue and corresponds to a hold voltage which specifically makes it possible to maintain the excitation of the cell after its addressing. For a grey level coded on n bits (the grey level for each of the components R G B is involved), the panel will be scanned n times in order to retranscribe this level, the duration of each of these sub-scans being proportional to the bit which it represents. By integration, the eye converts this "global" duration corresponding to the n bits into a value of illumination level. Sequential scanning of each of the bits of the binary word is therefore performed by applying a duration proportional to the weight. The addressing time of a pixel, for one bit, is the same irrespective of the weight of this bit, what changes is the illumination hold time for this bit.

Globally, a cell therefore possesses only two states: excited or non-excited. Therefore, unlike with a CRT, it is not possible to carry out analogue modulation of the light level emitted. In order to account for the various grey levels, it is necessary to perform temporal modulation of the duration of emission of the cell within the frame period (denoted T). This frame period is generally divided into as many sub-periods (sub-scans) as there are bits for coding the video (number of bits denoted n). It must be possible to reconstruct all the grey levels between 0 and 255 by combination on the basis of these n sub-periods. The observer's eye will integrate these n sub-periods over a frame period and thus recreate the desired grey level.

A panel is made up of Nl lines and Nc columns supplied by Nl line supply circuits and Nc column supply circuits. The generation of grey levels by temporal modulation requires that the panel be addressed n times for each pixel of each line. The matrix aspect of the panel will enable us to address all the pixels of the same line simultaneously by sending an electrical pulse of level Vccy to the line supply circuit. The signals transmitted to the columns are called column control words and relate to the video signal to be displayed, this relation being for example a transcoding dependent on the number of bits used. The video information

corresponding to the bit of this column control word addressed at this instant (corresponding to a sub-scan) will be present on each of the columns and will be manifested by an electrical pulse of "binary" amplitude 0 or Vccx (indicative of the state of the coded bit). Conjugation of the two voltages Vccx and Vccy at each electrode crossover will or will not lead to excitation of the cell. This state of excitation will then be sustained over a duration proportional to the weight of the sub-scan performed. This operation will be repeated for all the lines (Nl) and for all the bits addressed (n). It is therefore necessary to address n $\times$ Nl lines over the duration of the frame, thus giving the following fundamental relation:

$$T = n.N_l.t_{ad}$$

where tad is the time required to address a line.

A sequencing algorithm makes it possible to address all the lines n times while, between each addressing, complying with the respective weight of the sub-scan performed.

Let us turn to Figure 2 to provide a better explanation of the phenomenon of contouring.

In this figure, the abscissa axis represents time and is divided into frame periods of duration T. Each frame period is divided into sub-periods of time whose duration is proportional to the weight of the various sub-scans thus making it possible to define a video level to be displayed on the plasma screen, (1, 2, 4, 8..., 128) for a video quantized on 8 bits and an addressing possessing 8 sub-scans.

The ordinate axis represents the 0 or 1 level of the addressing bits during the corresponding frame periods, or stated otherwise the unlit or lit state of a cell as a function of time, for a given coding level.

Curve 5 corresponds to a coding of the value 128, curve 6 to a coding of the value 127 and curve 7 to a coding of the value 128 during the first frame and of the value 127 during the second frame and vice versa for the next two frames.

The principle of temporal modulation of the grey levels involves a temporal distribution of the n sub-scans which retranscribe the video over the 20 ms of the frame. If addressing on 8 sub-scans (n=8) is adopted, the transitions 127/128 and 128/127 entail a switching over of all the bits. Since the 8 sub-scans are distributed over the 20 ms of the frame, the eye, by integrating the video asynchronously, gives rise to the appearance of black areas, part b of curve 7 corresponding to a 0 level for the duration of two successive frames, and white areas, part a of curve 7 corresponding to a 1 level for the duration of two successive frames.

The phenomenon of contouring shows up particularly in moving areas where there are strong transitions (contours of objects) or more generally switchovers at the level of the high weights in the coding of this video. In the case of a colour screen, this is manifested by the appearance on the panel, in the region of these contours, of "false colours" due to erroneous interpretation of the triplet R G B. This phenomenon is therefore linked to the system for the temporal modulation of the level of the video and to the fact that the eye, in its role as integrator, gives rise to the appearance of incorrect contours.

A solution to this problem consists in coding the grey level to be transmitted on more bits than are theoretically necessary (8 to code 256 levels) and thus in defining more sub-scans so as to achieve better temporal distribution of the information. This is because, by increasing the number of sub-scans the respective weights of the sub-scans are decreased and the problems during their switchovers are limited. At the present time, given the characteristics of panels (number of lines Nl), and the time required to address a line (tad), it is possible to perform 10 sub-scans (n=10) in 20 ms. A transcoding of the grey level will for example be:

1 2 4 8 16 32 32 32 64 64.

The highest weights can therefore be 64 instead of 128.

This solution is however applied to the detriment of the quality of the image, the resolution being limited as a consequence.

To render a grey level on a plasma panel, it is necessary to perform a temporal modulation of this level by performing n successive sub-scans in the course of a frame. The sequencing algorithm for this addressing leads to the performance, in a nested fashion, of n sub-scans of the panel. However, in a desire to simplify the algorithm and the device implementing this addressing, a line l+1 is always addressed just after a line l for a given sub-scan.

A sequencing algorithm according to the prior art is represented in Figure 3 and is set forth hereinbelow so as to aid the understanding of the invention, by setting forth the differences relative to this prior art.

This sequencing algorithm is known by the title Simultaneous Addressing Scanning or SAS. It makes it possible to address all the lines n times (corresponding to the number n of bits) while complying, between each addressing, with the duration corresponding to the weight of the bit relating to this addressing. Each of the lines is addressed for each of the sub-scans in a defined order as shown in Figure 3 for a system with 4 sub-scans.

The horizontal axis represents the time t and the vertical axis the line number. Indicated on the time axis are the periods corresponding to the various sub-scans SB0 to SB3 for the bits 0 to 3 of column control words defining the luminance value to be displayed. The duration of display, in fact the holding duration after writing, is dependent on the weight of the bits of this control word. These durations are represented, for each of the bits 0 to 3, by two oblique solid lines respectively flanking each of the labels SB0 to SB3, for example the holding duration referenced 8 for sub-scan SB3. The shaded zones 9 and 11 correspond to the scanning of the previous frame and of the following frame and the intermediate zone 10 corresponds to the scanning of the current frame.

It is thus apparent that, for a given sub-scan, the lines are addressed in ascending order. On the other hand, there is nesting of various sub-scans, this implying that there is successive addressing of a line from the top of the panel for sub-scan SB1 for example and a line from the bottom of the panel for sub-scan SB2 the instant after. In practice, four consecutive lines are addressed successively in an addressing cycle which therefore sends four writing pulses before the sustain cycle.

Thus, if one considers for example the vertical band 12 corresponding to a short instant dt, the intersections with the oblique lines represent successively the write starts relating to sub-scans SB3, SB2, SB1 and SB0 of the same frame (in this example) which plotted on the ordinate axis correspond to line numbers l_3, l_3+1, l_3+2, l_3+3, for example 100 and the subsequent lines 101, 102 and 103 for SB3, l_2, l_2+1, l_2+2, l_2+3 for SB2, etc. These addressings of the 4 times 4 lines are carried out during a time interval dt. The instant after will write lines 104, 105, 106, 107 for SB3 and so on and so forth.

The new addressing process, the subject of this patent application, makes it possible to perform, at various instants (which are not successive), the writing of lines l and l+1. In fact it involves nesting 2 addressing algorithms, one for the even lines and the other for the odd lines. Overall, everything happens as if there were now an algorithm of 2*n sub-scans on Nl/2 lines, rather than an algorithm of n sub-scans on Nl lines. During an addressing cycle, instead of addressing the 4 successive lines (l, l+1, l+2, l+3), we now address the lines 2 by 2, i.e. (l, l+2, l+4, l+6) or (l+1, l+3, l+5, l+7) according to the line parity. This modification in the addressing relates mainly to the generation of the sequencing of the addressings of the various sub-scans.

Figure 4 shows how, temporally, the 2 addressing algorithms are nested. Everything happens as if in this case there were 8 sub-scans, each being applied to one line parity alone (even or odd).

The solid oblique lines correspond to sub-scans SB0 to SB3 and the dotted oblique lines to sub-scans SB'0 to SB'3.

For example at an instant t, the line addressed for sub-scan SB3 is an even line l_3 (in fact the group of four successive even lines l_3, l_3+3, l_3+4, l_3+6), the line addressed for sub-scan SB'2 is an odd line l'_2 (in fact the group of four odd lines l'_2, l'_2+2, l'_2+4, l'_2+6) and so on and so forth for the other sub-scans at this instant t.

It is observed that, if the even line l_3 is written at the instant t, the following odd line $l'_3 = l_3+1$ is written at a different instant t'.

The system for separating the addressings of lines l and l+1 therefore implies that the instants of addressing of these lines are different. As a consequence, when line l is addressed, line l+1 is experiencing a sustain phase. It is in fact possible to erase lines l and l+1 at this instant and to write the same video information on the 2 lines as explained hereinbelow. In the same way, it is possible to write the information on line l only, in this case the sustain phase for line l+1 will not be disturbed.

The nesting of the sub-scans SB' into the sub-scans SB can be entirely arbitrary and it is not necessary for any correlation to exist between the sub-scan instants of these two types (sub-scans of type SB for the even lines and sub-scan of type SB' for the odd lines). In the same way, the sustain durations may be completely uncorrelated and depend only on the weights of the bits of the column control words which will be assigned to each type of sub-scan. The weights of the column control words can be chosen to be different for sub-scan SB and for sub-scan SB'.

The diagrams of Figures 5 and 6 represent timing charts for two successive lines l and l+1 and the writing instants W for these lines.

The labels of type SB1 signify that this pertains to sub-scan 1 (bit n=1) for a type SB sub-scan.

T1 represents the corresponding holding duration of sub-scan SB1 (bit n=1).

The arrows appearing on the line Wl correspond to the instants of writing for line l.

Line l+1 is controlled by a nested sub-scan SB' as indicated earlier.

The labels of type SB'1 signify that this pertains to sub-scan 1 (bit n=1) for a type SB' sub-scan.

T'1 represents the corresponding holding duration of sub-scan SB'1 (bit n=1).

The arrows appearing on the line Wl+1 correspond to the instants of writing for line l+1.

The diagram of Figure 5 should be contrasted with that of Figure 4. In the case of Figure 5 we have:

- in line l:
  - a sub-scan 2 SB2 lasting T2
  - a sub-scan 3 SB3 lasting T3
- in line l+1:
  - a sub-scan 1 SB'1 lasting T'1
  - a sub-scan 2 SB'2 lasting T'2
  - a sub-scan 3 SB'3 lasting T'3.

The orders of writing are specific to a single line, the durations of the sub-scans are independent from one line to the other.

Referring to Figure 4 and considering for example the instant t, it is observed that, for a line l3, we begin sub-scan SB3 which is preceded by sub-scan SB2. In the next line l3+1 we are, at this instant t, in the midst of sub-scan SB'2 which overlaps sub-scan SB2 and sub-scan SB3, as is apparent in Figure 5.

Figure 6 makes no further reference to Figure 4 and gives, in a general manner, the scheme of the invention using nested scanning.

The first timing chart corresponds to line l and represents 4 successive sub-scans Sb1 to Sb4 of holding duration t1 to t4.

The second timing chart corresponds to line l+1 and represents 4 successive sub-scans Sb'1 to Sb'4 of holding duration t'1 to t'4.

We have:

- in line l:
  - a sub-scan 1 Sb1 lasting t1
  - a sub-scan 2 Sb2 lasting t2
  - a sub-scan 3 Sb3 lasting t3
  - a sub-scan 4 Sb4 lasting t4
- in line l+1:
  - a sub-scan 1 Sb'1 lasting t'1
  - a sub-scan 2 Sb'2 lasting t'2
  - a sub-scan 3 Sb'3 lasting t'3
  - a sub-scan 4 Sb'4 lasting t'4.

To go from the first case (Fig. 5) to the second case (Fig. 6), it is sufficient for the 3 writing signals which were specific (to each line) in the

first case to be made common (for the 2 lines I and I+1). The extra writing signals are enclosed in Figure 6 and designated under the reference 13.

Thus, by adding an extra first and second writing signal in line I (always preceded by an erasure signal in respect of the previous sub-scan), the holding duration T2 is split into two periods t1 and t2 and the holding duration T3 is split into two periods t3 and t4.

For the next line I+1, the addition of the writing signal makes it possible to split the holding duration T'2 into two periods t'2 and t'3.

On the basis of the nested sub-scans of type SB and SB', it is therefore possible to reduce to sub-scans which are common to lines I and I+1, both in terms of duration and video content (which is either zero, or one). It is thus possible to perform a line copyover. This line copyover will be dubbed "partial" in so far as it is performed on request. Specifically, the operation which has been performed in the example for the 3 writes can be reduced to 0 (this being the first case), to one or two writes.

The expressions partial copyover and on request are used because of the introduction of a concept of variable parameter which can be defined as a function of the video content.

The big advantage of this method resides in the fact that it is easy to go from a 16 sub-scan mode to a 13 sub-scan mode (see the example given below) from one frame to the other and with no transition cycle. The adaptation can therefore be carried out as a function of the content of the sequence and even as a function of the content of the image. A system for measuring the vertical resolution can be used to take a decision regarding the number of sub-scans to be used. The method even makes it possible to go, from one pair of lines to the other, from a 13 to 16 sub-scan mode. The decision information can be calculated for each pair of lines.

In what follows, we shall make explicit the scheme for separating the information between a common value and specific values, which process can be combined with our invention.

The coding of a grey level according to this scheme, which is manifested by a column control word, is performed by taking account not only of the luminance value of the pixel selected but also of the luminance value of the pixel lying in the adjacent line for the same column.

In fact, the column control word, for a given pixel, is separated into two parts, a first control word corresponding to a value common to the two pixels and a second and third control word corresponding to the specific values of the pixels.

It is desired to obtain the following coding:

- a value specific to line l coded on n1 bits
- a value specific to line l+1 coded on n2 bits
- a value common to lines l and l+1 coded on n3 bits

with the following relation:

$n1 + n2 + n3 = 2 \times$ (number of sub-scans per line).

If a given number of sub-scans is considered, it is in fact necessary for the number of sub-scans relating to the bits for coding the two specific values and the common value, namely $n1 + n2 + n3$, to correspond to that of the sub-scans performed in a conventional manner and relating to the coding bits for line l and to the coding bits for line l+1.

These various parameters n1, n2, n3 are not fixed. It is possible to modulate the relationship between the definition of the specific values and that of the common value. The better defined are the specific values, the smaller will be the coding-related loss of resolution. Conversely, the less well defined are the specific values, the higher will be the total number of sub-scans. There is therefore a compromise to be found between the loss of resolution on the one hand and the minimization of the defects of display on the other.

The calculation of the specific values is performed as follows:

The specific values for lines l and l+1 contain the information item regarding the difference between these lines l and l+1. This is because, if NG1 and NG2 denote the grey levels of the pixels of lines l and l+1, VS1 and VS2 their specific values and VC the common value, the following relation holds:

$NG1 = VS1 + VC$

$NG2 = VS2 + VC$

Consequently, VS1 - VS2 must be equal to NG1 - NG2 (so as always to have a zero coding error). When this difference between NG1 and NG2 (denoted D) has been determined, VS1 and VS2 are calculated by adding the term D and a portion α of the lowest grey level.

We then have:

if $NG1 > NG2$ $\quad VS1 = D + \alpha NG2$

$\quad VS2 = \alpha NG2$

if $NG2 > NG1$ $\quad VS1 = \alpha NG1$

$\quad VS2 = D + \alpha NG1$

The value of α is a parameter to be defined in the same way as n1, n2, n3. This value α is the result of algorithmic tests and is therefore partly determined empirically. The value is chosen as a function of the

calculations induced, for example the value 3/16 facilitating the calculations by the digital signal processor DSP.

The common value is calculated by differencing the initial value and the specific value. Given the approximations made in the calculation of the specific values, the common value is obtained through the following calculation:

$$VC = 1/2 \times (NG1 + NG2 - VS1 - VS2)$$

The calculations are therefore summarized by the following steps:

- determination of the value D corresponding to the difference between the two values to be coded NG1 and NG2,
- calculation of the specific values VS1 and VS2 as a function of D, α and NG1 or NG2,
- calculation of the common value VC as a function of NG1, NG2, VS1, VS2.

An important point consists in the minimization of the recoding error. To be able to minimize this recoding error, use will be made of a particular coding of the specific value. This is a coding in increments of 5, that is to say each code is a multiple of 5. The following table shows how the specific and common values are calculated to obtain, finally, the values VF1 and VF2 which are the closest possible to NG1 and NG2. In fact, the error (E1, E2) is limited to +/- 1.

NG1	NG2	D	D by 5	VS1	VS2	VC	VF1	VF2	E1	E2
60	65	5	5	10	15	50	60	65	0	0
60	66	6	5	10	15	50	60	65	0	-1
60	67	7	5	10	15	51	61	66	1	-1
60	68	8	10	10	20	49	59	69	-1	1
60	69	9	10	10	20	49	59	69	-1	0

The difference D between the grey values is coded on the basis of the closest multiple of 5 of this value D. The specific values VS1 and VS2 are multiples of 5 and the proportion of the specific value with respect to the global value (the parameter α) is chosen to be equal to 3/16. The value of VS1 is thus the value modulo 5 which comes closest to $60 \times 3/16$.

The specific value, which contains the information item regarding the difference between the two coded pixels, is defined only over a restricted number of bits. The maximum difference which it will be

possible to code will therefore be limited in fact to the maximum value which can be coded as a specific value. This will therefore prohibit us from coding large differences.

For a strong transition, since the difference which can be coded is limited, one of the specific values will be equal to the maximum value and the other will be equal to 0. The common value will for its part be determined in such a way as to minimize the error in the final value. In this case, the final error may be greater than 1.

The following table gives an example of a coding between 2 pixels whose difference is greater than the maximum definition of the specific value. The maximum value chosen for the specific value is taken to be equal to 70:

NG1	NG2	D	D by 5 limited	VS1	VS2	VC	VF1	VF2	E1	E2
10	100	90	70	0	70	20	20	90	10	-10

An example application implementing the scheme for separating the information between a common value and specific values is given below for a system allowing 10 sub-scans:

Definition of the parameters:

- n1 = 4 (code 5,10,20,35)
- n2 = 4 (code 5,10,20,35)
- n3 = 12 (code 1,2,4,6,9,12,15,19,23,27,31,36)
- $\alpha = 3/16$

This allows us in fact to transcribe a grey level as 16 sub-scans, 12 sub-scans being common to 2 lines (therfore equivalent to 6 conventional sub-scans) and 4 sub-scans being specific. In this case, the gain will be 6 sub-scans with a recoding error of less than or equal to 1 (for a difference between lines of less than or equal to 70).

Figure 7 shows such an addressing with 16 sub-scans. The sub-scans corresponding to the bits of weight 10, 9, 15, 12, 20 follow one another as a function of time in line l and line l+1. The writes referenced 14 are common to lines l and l+1, for the values 9, 15, 12. The writes reference 15 are specific to lines l and l+1 and relate to the values 10, 20.

The 16-bit code thus defined limits the maximum difference between lines l and l+1 to 70 (70 = 5+10+20+35). Beyond 70, the operation of coding on 16 bits entails the generation of an error greater than the LSB.

This problem is solved by combining the scheme of nesting the sub-scans with that described previously.

The 16-bit code hereinabove corresponds to the weight of the bits of the column control words calculated from the video information:

1 2 4 5 6 9 10 12 15 19 20 23 27 31 35 36

According to the scheme for separating the information between a common value and specific values, each video information item is separated into an information item specific to the current line l and an information item common to the 2 adjacent lines l and l+1. The specific information is coded on 4 bits whose respective weights are multiples of 5 (5, 10, 20, 35). The common information is coded on 12 bits.

The sub-scans nesting scheme makes it possible to increase the value of this maximum difference onwards of which the errors are no longer negligible, this being particularly useful when the vertical resolution (difference in luminance) is considerable.

It makes it possible to go dynamically from 16 sub-scans (10 sub-scans common to two lines and 4 separate sub-scans) to 13 sub-scans.

Firstly, the respective order of the various sub-scans is modified as follows:

1 2 4 6 5 10 9 15 12 20 19 23 27 31 36 35

This order defines the rank of the bits of the control words transmitted, represented by their weight.

The first 4 sub-scans (1, 2, 4, 6) are always common to the 2 adjacent lines. Sub-scans 5 and 10 and also 20, 35 are for their part always specific to lines l and l+1 (hence, there are always 2 different items of information for these sub-scans).

For the next 3 sub-scans (9, 15, 12) 2 cases are possible: either they are common to the 2 lines (and one then reverts to the 16 sub-scan addressing) or they are partially specific (13, 14 or 15 sub-scan addressing).

Figure 8 shows such a 13 sub-scan addressing. The sub-scans corresponding to bits of weight 10, 24, 12, 20 follow one another in line l. The sub-scans corresponding to bits of weight 10, 9, 27, 20 follow one another in line l+1. The writes referenced 16 are common to the lines l and l+1, for the values 9 and 24. The writes referenced 17 are specific to lines l and l+1 and relate to the values 10, 20, 12 and 27. In fact, it is the write relating to sub-scan 9 which is common but line l will not be erased at the end of the sustain cycle. If there is no erasure, the information written

remains present, this implying that the video information which has weight 9 in line l+1 has a different weight (24) in line l. On the other hand, line l+1 is erased at the end of the cycle of weight 9. At this instant, the next video information item will be written (which corresponds to 15 in the 16 sub-scan mode) in line l+1. In the same way, line l rather than line l+1 will be erased at the end of the cycle of weight 15. Hence, in line l there is a sub-scan of duration 24 (9+15) whose video content is the same as the sub-scan of duration 9 of line l+1. The video content of sub-scan 12 is then written in line l. In the same way, when writing the 12 in line l, no erasure has been performed in line l+1. As a consequence, the sub-scan 15 of line l+1 in fact lasts 27 (15+12). An erasure signal common to line l and l+1 is then performed before writing the video information corresponding to the specific values of weight 20.

In conclusion, in the 16 sub-scan mode, there were 3 successive common sub-scans of respective weights 9, 15, 12. In the 13 sub-scan mode there are in fact 2 sub-scans 24 and 12 in line l and 2 sub-scans 9 and 27 in line l+1. Only constraint, the information item 24 of line l and 9 of line l+1 are common. On the other hand, the weights 12 of line l and 27 or line l+1 are specific. Hence, the proportion of specific values is thus increased relative to the common values, this allowing greater vertical resolution.

In the same way, sub-scans 19, 23, 27, 31, 36 of a 16 sub-scan addressing can be transformed into 3 sub-scans 42, 58, 36 for line l and 19, 50, 67 for line l+1. Only constraint, the video information of sub-scan 42 of line l is the same as that of sub-scan 19 or line l+1.

For the coding of the values 9, 15, 12, a saving of one sub-scan was made, for the coding of the values 19, 23, 27, 31, 36, a saving of another two sub-scans was made.

By taking account of the specific sub-scans and of those common to two lines, let us calculate the number of writes for two successive lines so as to check the average number of sub-scans per line:

- 4 writes corresponding to 4 common sub-scans (1, 2, 4, 6)
- 4 × 2 writes corresponding to 4 specific sub-scans (5, 10, 20, 35)
- 1 write corresponding to 1 common sub-scan (9 + 15 for l and 9 for l+1 being limited to 1 write control common to the two lines for sub-scan 9)
- 1 × 2 writes corresponding to 2 specific sub-scans (12 for l and 15 + 12 for l+1)

- 1 write corresponding to 1 common sub-scan (19 + 23 for I and 19 for I+1 being limited to 1 write control common to 2 lines for sub-scan 19)

- 1 × 2 writes corresponding to 2 specific sub-scans (27 + 31 for I, 23 + 27 for I+1)

- 1 × 2 writes corresponding to 2 specific sub-scans (36 for I, 31 + 36 for I+1).

I.e., a total of:

4 + 8 + 1 + 2 + 1 + 2 + 2 = 20 writes.

An average of 10 writes per line is clearly found.

Alternatively, it may be stated that the column control words were coded on 16 bits and, according to the weight of the bits, the lines were addressed separately or 2 by 2. The scan time for writing the 2 bits, for which the lines were addressed 2 by 2, was therefore halved, reducing the scan time to that of a column control word of 10 bits (4 + 12/2).

According to the sub-scans nesting scheme, the column control words are coded on 13 bits, some bits being common to two successive lines.

These column control words have bits of different weights depending on whether the relevant line is an even or odd line.

The weights of the column control words coded on 13 bits (13 sub-scans) are:

- for an even line (or odd line according to the choice thereof):

1, 2, 4, 6, 5, 10, 24, 12, 20, 42, 58, 36, 35

- for an odd line (respectively even line):

1, 2, 4, 6, 5, 10, 9, 27, 20, 19, 50, 67, 35

The weights of the bits of rank 7 and 8 have the same sum 36. The weights of the bits of rank 10, 11, 12 have the same sum 136.

The lines are addressed 2 by 2, in the example, for the weights:

1, 2, 4, 6, 9 or 24, 19 or 42 (according to the relevant column control word).

The lines are addressed separately for the weights 5, 10, 20, 35.

The lines are addressed separately for the weight (15 + 12), (23 + 27), (31 + 36).

The lines are addressed separately for the weight 12, (27 + 31), 36.

A scan time for writing is obtained which corresponds clearly to 10 bits:

4/2 + 2/2 + 4 + 6/2 = 10

Overall, by virtue of the invention, we go from a maximum difference of 70 for 16 sub-scans to a difference of 176 (255-42-24-13) for 13 sub-scans (the values 9/24 and 19/42, since the weights 1, 2, 4, 6 cannot in fact be selected separately). This therefore makes it possible to considerably increase the vertical resolution transmitted.

The big benefit of this technique is that it is possible to carry out the switchover between a 16 sub-scan addressing and a 13 sub-scan addressing on request and for a given pair of lines. It is possible for example to detect upstream the zones of the image possessing strong vertical transitions. All the lines of this zone will then be visited in 13 sub-scan addressing, the others possibly remaining in 16 sub-scan addressing. This switchover, which corresponds to going from an addressing in accordance with Figure 8 to an addressing in accordance with Figure 7 is carried out in a simple manner, by replacing the selection of a line l (or of a line l+1) during the writing of a bit of different weight in line l (or l+1) by the selecting of line l and of the immediately following (or preceding) line for simultaneous writing on both these lines.

In the same way, it will be beneficial to possess a "false contours" detector to assess the necessity or otherwise to remain in 16 sub-scan mode. There is a compromise to be found between the vertical resolution and the limiting of the level of "false contours".

This number of sub-scans is connected with the number of bits having different weights from a column control word corresponding to a line to the column control word corresponding to the next line and this number, hence the column control words used for the coding of the image can be chosen as a function of the images to be processed, it moreover being possible for this choice to be made image by image. The weight of the relevant bits may be chosen as a function of the resolution of the image.

The problems of cell priming and of quantization which were described earlier can be attenuated as follows:

By using just the scheme for separating the addressings of lines l and l+1 it is possible to improve, in a fairly simple manner, the priming of the excitations. Specifically, during conventional addressing, the 4 cells addressed in the course of the current cycle are firstly turned off by an erasure pulse. The write which follows just afterwards cannot benefit from a proximity effect of illuminated cells. The only cells which can be illuminated are those situated just above or below the packet of 4 lines.

In our case, lines I and I+1 being addressed at different instants, line I+1 can benefit from the state of possible excitation of lines I and I+2, the latter not having been turned off just before. In fact, it is possible to make all the sub-scans benefit from all the lines of this system.

To promote the priming of all the sub-scans, it is sufficient to have instants of writing on the even and odd lines which are systematically different. A simple way of achieving this is to offset the 2 addressing systems by a constant time, while in this case retaining the same code on both lines. It is for example possible to use a double addressing system, the one offset with respect to the other by the equivalent of 1/2 LSB.

In the example of Figure 8, configuration with 13 sub-scans, certain sub-scans benefit from this promoted priming.

Regarding the quantizing of the low levels, if one considers 2 separate addressings for the odd lines and the even lines, it is possible, as was indicated earlier, to perform a common write for 2 adjacent lines at a given moment. This amounts for example to halting the sustain phase of a sub-scan of line I and to writing the video information of line I+1 to lines I and I+1. The duration of the initial sub-scan of line I is in this case reduced. Applying this scheme in respect of the sub-scan corresponding to the lowest weight (duration corresponding to the LSB) amounts to introducing a quantization interval of less than the LSB. The phase shift between the 2 addressings can be chosen to be equal to 1/2 LSB. If the common addressing scheme is applied to the 2 adjacent lines, then sub-scans of weight 1/2 LSB are defined. This gains us a quantization level which can be used especially for the low levels. It is also possible to define an addressing system making it possible to increase this quantization even further by introducing the weight of 1/4 of the LSB.

An exemplary embodiment of the device implementing the scanning process is described hereinbelow. The simplified chart of the control circuits of a plasma panel 18 is represented in Figure 9.

The digital video information arrives at the input E of the device which is also the input of a video processing circuit based on a microprocessor 19 and the input of a selection circuit 20. The video processing circuit is linked to a correspondence memory 21, to the selection circuit 20, to the input of a video memory 22 and to a scan generator or circuit for controlling the line supply circuits 24. The video memory transmits the stored information to the input of a circuit 23 which groups together the column supply circuits.

The scan generator 24 transmits synchronization information to the video memory 22 and controls a circuit 25 which groups together the line supply circuits.

The video information coded on 8 bits and received on the input E are thus transmitted to the selection circuit 20 which stores the video data on a complete image. This circuit analyses the content of the video and calculates the number of times that there is, in the image, a difference in luminance between line l and line l+1 which is greater than a preset threshold.

If this number is greater than a predetermined threshold, the scan is performed utilizing the sub-scans nesting scheme, that is to say on the basis of a 13 sub-scan addressing. In the contrary case, 16 sub-scans are performed. The information relating to the type of scan is transmitted to the processing circuit 19 which carries out the coding of the video information accordingly. The processing circuit transmits this information to the scanning circuit 24 so that it carries out the scanning of the screen as a function of this coding.

The processing circuit 19 exchanges the video data with the correspondence memory or table 21 which, as a function of the values of the video words sent as addresses, will provide words as data, the words corresponding to codes on 13 or 16 bits whose weights will have previously been defined. This transcoding from the correspondence table 21 is defined as a function of the mode of addressing utilized.

When the 13 sub-scan mode of addressing is selected, the words coded on 13 bits correspond to two types of coding which are differentiated by the weight of the bits of the coded words:

- a first type of coding providing a first coding word corresponding to the even lines of the plasma panel
- a second type of coding providing a second coding word corresponding to the odd lines of the plasma panel.

These words are then transmitted to the video memory 22 which stores them so as to provide the column supply circuits with the successive bits of the column control words, in synchronization with the line scan.

The scan generator 24 carries out, over the duration of a frame and by way of the line supply circuits 25, the line scanning of the screen. This circuit 25 provides the addressing voltage and also the holding voltage for the duration corresponding to the sub-scan relating to the weight of the bit sent to the columns for this addressing.

The scan generator 24 performs the sub-scans as a function of the commands received from the processing circuit.

The types of scans implemented are:

- a scan of the lines selected two by two (simultaneous selection of lines 2l and 2l+1)

- a scan of each successive line.

The switch from a 13 sub-scan mode to a 16 sub-scan mode is done very simply by selecting lines 2l and 2l+1 instead of line 2l alone or line 2l+1 alone when writing the bits corresponding to the common value VC.

It should be noted that the selection circuit 20 can clearly be placed upstream of the device and in particular of the processing circuit so as to avoid any delay in the coding of the video words.

Of course, the above description assumed a line selection of the plasma panel for a transmission of video information on the column inputs of the display, but other types of addressing could be envisaged, for example by reversing the function of the lines and columns without the process departing from the field of the invention.

Clearly, the invention is not limited by the number of bits which quantize the digital video signal to be displayed, nor the number of sub-scans.

It may be applied equally to any type of screen or device with matrix addressing which utilizes modulation of the temporal type for the displaying of luminance or grey levels corresponding to each of the three components R G B. The cells of this device or matrix array with line inputs and column inputs, here the term cell being taken in the broad sense of elements at the intersection of the lines and columns, may be cells of plasma panels or else micromirrors of micromirror circuits. Instead of emitting light directly, these micromirrors reflect received light in a pointwise manner (a cell corresponding to a micromirror), when they are selected. Their addressing in respect of selection is then identical to the addressing of the cells of plasma panels such as is described in the present application.